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WD # 491220

CLEAN VERSION OF PENDING CLAIMS

METHOD TO REDUCE FIXED CHARGE IN CVD OZONE DEPOSITED FILMS
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Serial No: 08/636069

Claims 1, 2, 4-6, 31-36, and 38-54, as March 4, 2003 (Date of Response to First Office Action after Appeal).

SUB I1 H1

1. (Amended) A chemical vapor deposition (CVD) process for depositing borophosphosilicate glass films on a substrate surface, the process comprising:

disposing the substrate within a chemical vapor deposition reaction chamber;

heating the substrate to a temperature within a range of at least 480°C to about 700°C;

introducing a gas volume of SiO2 precursors into the chamber;

admitting a gas volume of ozone into the chamber;

admitting a dopant source for phosphorus into the chamber;

admitting a dopant source for boron into the chamber; and

exposing a reaction volume of gases located above the substrate surface within a chemically reactive distance of the substrate to a high intensity light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the borophosphosilicate layer.

2. The method of Claim 1, wherein the SiO2 precursor is selected from the group consisting of TEOS (tetraethylorthosilicate), TMCTS (tetramethylcyclotetrasiloxane), DES (diethylsilane), DTBS (ditertiarybutylsilane), TMOS (tetramethylorthosilicate) and FTES (fluorotriethoxysilane).

4. The method of Claim 1, wherein the dopant source for boron is selected from the group consisting of triisopropylborate, TMB (trimethylborate), and TEB (triethylborate), and

the dopant source for phosphorus is selected from the group consisting of TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite).

5. The method of Claim 1, further comprising introducing a gas volume of a carrier gas into the reaction chamber.

6. The method of Claim 5, wherein the dopant source for boron is selected from the group consisting of triisopropylborate, TMB (trimethylborate) and TEB (triethylborate), and the dopant source for phosphorus is selected from the group consisting of TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite).

31. A method of depositing a silicon dioxide layer on a substrate surface, the method comprising:

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO2 precursor and ozone;

heating the substrate surface to a temperature of at least 480°C to about 700°C; and

illuminating the reaction volume of gas from a light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than in homogeneous reactions taking place in the chamber outside of the reaction volume, subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

32. The method of Claim 31, wherein the light source comprises mercury arc vapor lamps.

33. The method of Claim 31, wherein the reaction volume of gas further comprises a carrier gas.

34. The method of Claim 31, wherein the reaction volume of gas further comprises a carrier gas selected from the group consisting of the Noble gases, nitrogen and hydrogen.

35. The method of Claim 31, wherein the reaction volume of gas further comprises a carrier gas comprising helium.

36. The method of Claim 31, wherein ozone comprises approximately 5% to 15% by volume of the reaction volume of gas.

38. The method of Claim 31, further comprising:

subjecting the reaction volume of gas to a pressure of approximately 200 torr during deposition of the silicon dioxide layer.

39. The method of Claim 31, wherein the SiO2 precursor is selected from the group consisting of TEOS (tetraethylorthosilicate), TMCTS (tetramethylcyclotetrasiloxane), DES (diethylsilane), DTBS (ditertiarybutylsilane), TMOS (tetramethylorthosilicate) and FTES (fluorotriethoxysilane).

40. The method of Claim 31, wherein the reaction volume of gas further comprises at least one dopant source selected from the group consisting of triisopropylborate, TMB (trimethylborate), TEB (triethylborate), TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite).

41. The method of Claim 31, wherein the reaction volume of gas further comprises at least one dopant source for boron selected from the group consisting of triisopropylborate, TMB (trimethylborate), and TEB (triethylborate), and at least one dopant source for phosphorus selected from the group consisting of TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite).

42. A method of depositing a doped silicon dioxide layer on a substrate surface, the method comprising:

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO2 precursor, ozone and at least one dopant source;

heating the substrate surface to a temperature of at least 480°C to about 700°C; and

illuminating the reaction volume of gas from a light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

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16 ~~43.~~ (Amended) A method of depositing a doped silicon dioxide layer on a substrate surface, comprising:

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO2 precursor, ozone and at least two dopant sources;

heating the substrate surface to a temperature of at least 480°C to about 700°C; and

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illuminating the reaction volume of gas from a light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

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17 ~~44.~~ The method of Claim 16 ~~43~~, wherein the at least two dopant sources comprise a dopant source for boron and a dopant source for phosphorus.

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18 ~~45.~~ (Amended) A method of depositing a borophosphosilicate glass layer on a substrate surface, comprising:

heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, wherein the reaction volume of gas comprises:

a SiO_2 precursor selected from the group consisting of TEOS (tetraethylorthosilicate), TMCTS (tetramethylcyclotetrasiloxane), DES (diethylsilane), DTBS (ditertiarybutylsilane) and TMOS (tetramethylorthosilicate);

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a dopant source for boron selected from the group consisting of triisopropylborate, TMB (trimethylborate), and TEB (triethylborate); and

a dopant source for phosphorus selected from the group consisting of TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite);

illuminating the reaction volume of gas from a high intensity light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

19 ~~46~~. (Amended) A method of depositing a fluorosilicate glass layer on a substrate surface, comprising:

heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a fluorinated SiO_2 precursor and ozone; and

illuminating the reaction volume of gas from a light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the

reaction volume take part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the fluorosilicate layer.

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20 ~~47~~. (Amended) A method of depositing a doped fluorosilicate glass layer on a substrate surface, the method comprising:

heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a fluorinated SiO2 precursor, ozone and at least one dopant source; and

illuminating the ~~reaction~~ volume of gas from a light source without directly exposing the substrate surface ~~to~~ the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

21 ~~48~~. (Amended) A method of depositing a doped fluorosilicate glass layer on a substrate surface, the method comprising:

heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a fluorinated SiO2 precursor, ozone and at least two dopant sources; and

illuminating the reaction volume of gas from a high-intensity light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in

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the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the fluorosilicate layer.

22 ~~49~~. The method of Claim 21 ~~48~~, wherein the at least two dopant sources comprise a dopant source for boron and a dopant source for phosphorus.

23 ~~50~~. (Amended) A method of depositing a fluoroborophosphosilicate glass layer on a substrate surface, the method comprising:

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heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, wherein the reaction volume of gas comprises:

a SiO2 precursor comprising FTES (fluorotriethoxysilane);

a dopant source for boron selected from the group consisting of triisopropylborate, TMB (trimethylborate), and TEB (triethylborate); and

a dopant source for phosphorus selected from the group consisting of TEPo (triethylphosphate), TEPi (triethylphosphite), TMPo (trimethylphosphate) and TMPi (trimethylphosphite); and

illuminating the reaction volume of gas from a high intensity light source without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the fluoroborophosphosilicate layer.

51. A method of depositing a silicon dioxide layer on a substrate surface, the method comprising:

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO2 precursor and ozone;

heating the substrate surface to a temperature of at least 480°C to about 700°C; and

illuminating the reaction volume of gas from a light source comprising mercury arc vapor lamps without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

52. A method of depositing a doped silicon dioxide layer on a substrate surface, the method comprising:

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO2 precursor, ozone and at least one dopant source;

heating the substrate surface to a temperature of at least 480°C to about 700°C; and

illuminating the reaction volume of gas from a light source comprising mercury arc vapor lamps without directly exposing the substrate surface to the light source to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

H5 / 26 ~~53.~~ (Amended) ~~A method~~ of depositing a doped silicon dioxide layer on a substrate surface, the method ~~comprising~~:

heating the substrate surface to a temperature of at least 480°C to about 700°C;

contacting the substrate surface with a reaction volume of gas located above the substrate surface within a chemically reactive distance of the substrate, the reaction volume of gas comprising a SiO_2 precursor, ozone and at least two dopant sources; and

illuminating the reaction volume of gas from a light source without directly exposing the substrate surface to the light source, the light source comprising mercury arc vapor lamps to increase the functional atomic oxygen concentration and reduce the fixed charge in the deposited films, the reactant gases in the reaction volume taking part in heterogeneous chemical reactions, rather than homogeneous reactions taking place in the chamber outside of the reaction volume; and

subjecting the reaction volume of gas to a pressure of approximately 200 to 760 torr during deposition of the silicon dioxide layer.

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54. The method of Claim 53, wherein the at least two dopant sources comprise a dopant source for boron and a dopant source for phosphorus.